Before the
Federal Communications Commission
Washington, D.C. 20554

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| In the Matter of | ) | WT Docket No.97-12 |
| | ) | |
| Amendment of Amateur Service | ) | RM-8737 |
| Rules to Provide For | ) | |
| Greater Use of Spread | ) | |
| Spectrum Communication | ) | |
| Technologies | ) | |





To: The Commission

REPLY OF GLENN E. ELMORE, N6GN

## I. Background

I have been licensed in the Amateur Radio Service since 1961 when I was 11 years of age. I have held an Amateur Extra class license for most of the time since and amateur radio has been very important to me for the entire period. My amateur activities have included the following:

- multimode HF,
- VHF through microwave weak-signal and long distance
- amateur satellites, OSCARS 1-13,
- meteor scatter,
- earth-moon-earth (EME),
- extensive VHF-microwave propagation monitoring and analysis
- design, development and publication of:
  - multimode, multiband microwave equipment,
  - theory of the physical layer in amateur radio networks
  - higher speed digital UHF & microwave data links and networks
  - direct sequence spread spectrum amateur equipment
  - on-channel active repeaters

## II. Introduction

I am responding to previous comments to the proposed Rule Making contained in this proceeding because I believe I have experience relevant to activities represented by commenters expressing divergent viewpoints. I hope that my experiences with weak-signal VHF through microwave, signal propagation, satellites, and EME along with those in digital radio, links and networks and spread spectrum may be helpful in this rule making process.

III. Summary

I generally welcome and support the rule changes proposed by the Commission. I believe that the use of spread spectrum for experimentation and communication is of very significant value to the amateur service. While I understand and share the concern of previous commenters that existing activities could be compromised, I believe that the reality of the amateur and physical environment is such that very minimal and managable interference problems will be the norm. I believe that existing amateur rules combined with amateur cooperation can and should be used to assure that experimentation and the rich diversity of pursuits within the amateur service may be maintained and furthered.

1. I specifically ask that the ruling not include any exclusion of SS operation in the central portions of the UHF and microwave bands.

2. I ask that the requirement for automatic power control not be included.

3. I ask that the 100W power limitation be waived for space applications.

4. I ask that SS operation be permitted on all amateur bands, including HF.

IV. Discussion

1. EME Interference

There has been concern expressed by commenters that existing weak-signal amateur activities, such as EME and satellite operations, will be severely threatened by relaxation of the spread spectrum rules. As a former amateur EME operator I would like to reply to that concern.

I have enjoyed amateur EME communication and desire to see it continue. In the mid 1980s, prior to delving into higher speed digital radio hardware, I built and operated a 432 MHz EME station over 2-3 years and several EME contests. The transmitter ran about 650 watts output to a home-built 24' stressed parabolic antenna. The station made many contacts in many continents and was capable of hearing its own echoes on SSB when conditions were good.

The station was located in Santa Rosa, CA about 50-80 miles north of the San Francisco Bay area which had a moderate amount of terrestrial activity at the time. However, to my knowledge, there was never a QRM/congestion problem of any kind. In fact, the gain of a skyward pointed EME dish is intentionally low toward the side (horizon) and back (earth). If this were not so, the system noise temperature would be degraded by terra firma which is ~290 Kelvin. Comparing the rise in noise floor when the an EME antenna is pointed toward the horizon or ground with what it is when the antenna is pointed toward a "cold" spot in the sky is actually an excellent proof-of-system-performance used by EME operators. With the very weak signals and tight link budgets of EME it is extremely helpful to have a way to know that the reason you don't hear anything "isn't you". Low sidelobes and good front/back antennas are part of EME.

Even receiving other local EME stations running very high power isn't as easy as might be thought. Since both stations are typically working each other off the sides of their antennas, which have considerable front/side ratio, even with high power signals aren't all that strong. Combined with typical excess path losses due to terrain and location, signals are most often unremarkable or even small. On many occasions I have mistaken a local kilowatt EME station (~50 miles away) for a signal reflected from the moon because signals were so weak.

On the few occasions when the dish was aimed at local terrestrial stations, signal strengths were indeed impressive. But even from a distance as large as the 50+ miles, antenna directivity was such that it wasn't possible to even *copy* all stations without moving the antenna. Terrestrial path losses combined with antenna patterns just don't allow the "band obliterating" signals that one might think. From my experience I would say that a good tropospheric duct tends to generate a lot more noticeable RF than EME stations. It sure generates a lot more interest!

2. Satellite Interference

For satellite operations, signals are generally stronger and round trip path losses a good deal less than for EME. Even using non-spread signals it is not usual for amateurs to inadvertently generate high enough ERP towards a satellite to be noticed. Although additional terrestrial path losses are avoided on a freespace path to a satellite, communication through one at UHF and above generally requires antenna directivity and deliberate attention to maximizing ERP in the appropriate direction. With spreading added, the chances of unintentional interference are further reduced. As with EME, antenna directivity and typical excess path loss serve to greatly reduce the signal at other terrestrial sites. Interference to nearby terrestrial stations is limited by the same mechanisms as described above for EME. While interference is possible, I believe it is much less likely and a smaller problem than previous commenters fear.

Whether signals are SS or narrow, my experience at VHF and above, even with high power levels and large ERPs, is that small signals predominate in the amateur environment. As received at most amateur locations, I believe that the largest signals come from well situated transmitters which run relatively low power and low gain antennas and thus relatively low ERP. Repeaters are a common example. It's possible to find exceptions to this but from my experience, this is what predominates. The combination of antenna directivity and excess losses due to terrain, foliage and antenna height at most amateur installations typically produce far less signal at a distant receiver than that predicted by the freespace pathloss equation.

This large reduction in signal strength over typical paths, well above and beyond that predicted by freespace pathloss calculations, is the fundamental reason that handheld radios are so often operated in conjunction with well-situated repeaters. This is not restricted to the amateur radio environment, it is a dominant characteristic of terrestrial communications at VHF and above. It is one reason that applications like cellular telephones, which are otherwise capable of communicating hundreds or even thousands of miles in freespace, require cell sizes on the order of a few miles in diameter.

The magnitude of this signal reduction is greatly underestimated by most amateurs. The fact that two 5W, 146 MHz handheld transceivers with dipole antennas are capable of communicating on the order of 10,000 miles in freespace but often not over 10 miles in typical amateur locations is hard for many to believe.

3. Experiences With Coexisting Spread and Non-Spread Radios

During the last several years I have built and operated hardware and software which supports higher speed amateur radio networking. This has involved the design and fabrication of high speed digital radio hardware as well as extensive site and path analysis and measurement. These activities have also been a vehicle for testing the effects of SS Part 15 devices and other potential interferers on non-spread wideband communications systems. The wideband simple FSK radios being used had fairly poor tolerance of signal loss as well as of even brief interference such as that produced by FHSS devices.

In addition to nearly continual operation and monitoring of performance from a residential location over a period of several years in which Part 15 device usage in the same band was proliferating, multiple Part 15 SS transceivers (Metricom) were also co-located at the site of a key node in this digital radio network.

To my surprise, the results of these tests indicated almost no degradation in performance due to Part 15 device interference. While many Part 15 transmitters have been evident, from within a few feet to several miles of the non-spread system radios, antenna directivity combined with the spreading has virtually eliminated any loss-of-service problems.

4. The Value of Spread Spectrum to the Amateur Service

I view the amateur service as many things; a hobby, a public service, a medium to foster international good will and a means to develop interest and skills in radio, electronics and communications. It has served me wonderfully and I sincerely desire to see it continue in that same richness and diversity. I thank and support the Commission for everything that they have done and can do to further amateur radio. I believe this serves the American people well.

However, in order to stay vital, I believe the service also needs to stay relevant to the age it is in. We are now said to be in the "information age". As such, I believe that an increasingly important aspect of amateur radio is its ability to communicate quantity of information over significant distances. This trend does not displace, but rather augments existing "lower bandwidth" activities and endeavors of the service.

As indicated by Shannon's well-known channel capacity equation, high information content communication requires increasingly high bandwidths. For radio communication, this requires systems which more closely approach freespace losses and tolerate the distortions introduced by propagation in the real-world. I believe that biggest gains in high information amateur communications and networks can only come about through the use of the wide bandwidths and antenna directivity available on the UHF and microwave bands while at the same time achieving pathlosses closer to freespace. However, I believe that spread spectrum techniques are also of great importance in economically reducing the multipath distortion which accompanies typical paths and which in the absence of corrective action severely limits channel capacity.

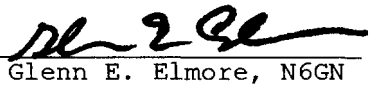
For these reasons I request that the Commission's rule making do nothing to limit the bandwidth of SS operation in the amateur UHF and microwave bands.

5. The Amateur Service as a Shared Resource

In addition to the need for relaxed rules for wideband spread spectrum operation at UHF and microwave, I believe that development and experimentation with these techniques is best supported by a minimum of additional regulations. I agree with the statements by TAPR and the amended statement by Karn that would remove the requirement for automatic power control from SS operations. In general I believe that the amateur service can and must continue to be largely self regulating and policing, within the general bounds established by the Commission. I believe that this is the only practical way that effective sharing of the amateur spectrum may be accomplished. This approach is not without the potential for contention and discord but I believe it offers the only practical method for sharing resources.

For this same reason and to promote experimentation, I also request that the Commission allow spread spectrum operation in the HF bands and waive the 100W power limitation for space communications with the expectation that existing rules and amateurs' ability to self-regulate will produce the best outcome for the service as a whole.

RESPECTFULLY SUBMITTED,

By 
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June 3, 1997

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